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IS 11428-1 to 3 (1985): Wrought Carbon Steel Butt-Welding  
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# *Indian Standard*

## SPECIFICATION FOR WROUGHT CARBON STEEL BUTT-WELDING PIPE FITTINGS

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## SPECIFICATION FOR WROUGHT CARBON STEEL BUTT-WELDING PIPE FITTINGS

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## *Indian Standard*

# SPECIFICATION FOR WROUGHT CARBON STEEL BUTT-WELDING PIPE FITTINGS

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 25 July 1985, after the draft finalized by the Steel Tubes, Pipes and Fittings Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** Steel butt welding pipe fittings are used in refineries, petrochemical industries and power pipings. This standard is being formulated to cover their quality and essential dimensions.

**0.3** To facilitate additions and alterations to the standard and to provide convenience to the users of the standard, the standard is being published in three parts as given below:

Part 1 General,

Part 2 Shapes and Dimensions, and

Part 3 Tolerances.

**0.4** In the preparation of this standard, assistance has been derived from the following :

ANSI B 16.9-1978      Specification for factory made wrought carbon steel butt-welding fittings. American National Standards Institution.

ANSI B 16.28-1978      Specification for wrought steel butt welding short radius elbows and returns. American National Standards Institution.

ANSI B 36.10-1979      Welded and seamless wrought steel pipes American National Standards Institution.

B.S. 1640 : Part 3 1968      Specification for steel butt welding pipe fittings for the petroleum industry. British Standards Institution.

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- |                 |                                                                                                                                             |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A 106-1983 | Seamless carbon steel pipe for high temperature service. American Society for Testing and Materials.                                        |
| ASTM A 234-1982 | Piping fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures. American Society for Testing and Materials. |

**0.5** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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\*Rules for rounding off numerical values ( *revised* ).



# *Indian Standard*

## SPECIFICATION FOR WROUGHT CARBON STEEL BUTT-WELDING PIPE FITTINGS

### PART 1 GENERAL

#### 1. SCOPE

**1.1** This standard ( Part 1 ) covers the material, dimensions, manufacturing and inspection requirements for wrought carbon steel butt welding pipe fittings.

**1.2** Fittings may be made of special dimensions other than those specified in the standard by agreement between the manufacturer and the purchaser.

#### 2. TYPES

**2.1** Butt-welding pipe fittings shall be of the following types:

- a) Elbows, 90° short radius,
- b) Elbows, 45° and 90° long radius,
- c) Eccentric reducers,
- d) Concentric reducers,
- e) 180° long and short radius returns,
- f) Caps,
- g) Equal tees and crosses, and
- h) Unequal tees and crosses.

**2.2** The diagrammatic representation of these types is given in Table 1.

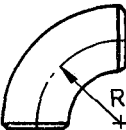
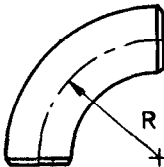
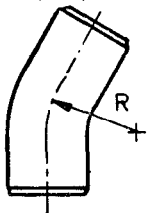

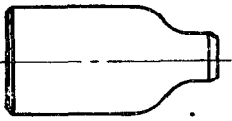

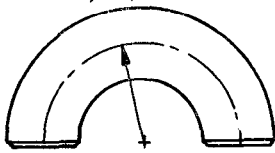
#### 3. DESIGNATION

**3.1** Butt-welded pipe fittings are designated giving the following particulars in the sequence shown:

- a) Type of fitting ( *see 3.1.1* ),
- b) Size designation ( *see 3.1.2* ), and
- c) Code number ( *see 3.1.3* ).

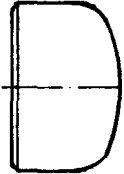
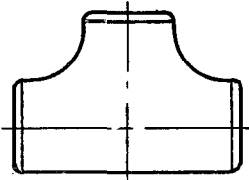
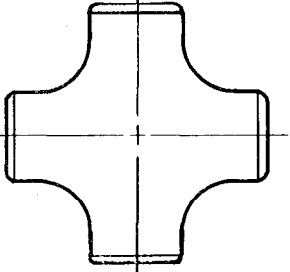
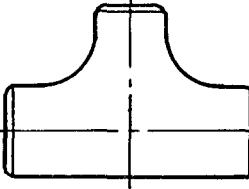
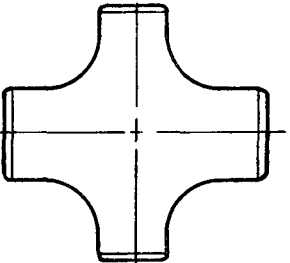
TABLE 1 DESIGNATIONS AND CODE NUMBERS

( Clauses 2.2, 3.1.3 and 3.1.5 )

A ELBOWS	1,A1/90° 	2,A2/90° 	3,A3/45° 
	1,B1 		2,B2 
	1,C1/180° 	2,C2/180° 	

( Continued )

TABLE 1 DESIGNATIONS AND CODE NUMBERS — *Contd*

D CAPS	1,D1 	
E1 TEES/ CROSSES (EQUAL)	1,E1 	2,E1 
E2 TEES CROSSES (UNEQUAL)	1,E2 	2,E2 

**3.1.1 Type of Fitting** — The type of fitting is denoted as elbow, reducer, cap, tee, etc.

**3.1.2 Size Designation** — The sizes of the fittings in the various tables are identified by the corresponding nominal pipe size. For fittings 350 mm and larger, outer diameter of the pipes corresponds with the nominal size.

**3.1.3 Code Number** — The code numbers for designating the various types of fittings are specified in Table 1.

### 3.1.4 Examples of Designations

<i>Fitting</i>	<i>Designation</i>
a) Elbows — 90° short radius ( $R = 1 D$ )	Elbow 1, A1
b) Elbows — 90° long radius ( $R = 1.5 D$ )	Elbows 1, A2
c) Elbows — 45° long radius ( $R = 1.5 D$ )	Elbows 3, A3
d) Eccentric reducers — Reducers	1, B1
e) Concentric reducers — Reducers	2, B2
f) Returns — 180° short radius ( $R = 1D$ )	Return 1, C1
g) Returns — 180° long radius ( $R = 1.5D$ )	Return 2, C2
h) Caps — Caps	1, D1.
j) Equal tees and crosses	Tees 1, E1 and 2, E1
k) Unequal tees and crosses	Tees 1, E2 and 2, E2

**3.1.5** Designations of various types of fittings are given in Table 1.

## 4. MATERIAL

**4.1** Steel to be used for the preparation of fittings required by this standard shall conform to one of the grades specified in Table 2. Other material may also be used as agreed between the purchaser and the manufacturer.

**TABLE 2 CHEMICAL COMPOSITION**

GRADE	C	Mn	Si	S	P
	<i>Max</i>		<i>Min</i>	<i>Max</i>	<i>Max</i>
1	0.25	0.30-0.90	0.10	0.050	0.050
2	0.30	0.30-1.06	0.10	0.050	0.050

**4.2** Where so required, the tubes, plates and forgings used for the manufacture of fittings shall be as agreed between the purchaser and the manufacturer.

**4.3** Where so required, the tubes used for the manufacture of fittings shall comply with the tests given in **4.3.1**, **4.3.2** and **4.3.3**.

**4.3.1 Flattening Test** — For pipe over 50 mm nominal diameter a section of pipe not less than 65 mm in length shall be flattened cold between parallel plates until the opposite walls of the pipe meet. No cracks or

breaks in the metal shall occur until the distance between the plates is less than that calculated from the value of  $H$  by the following equation:

$$H = \frac{(1 + e) t}{e + t/D}$$

where

$H$  = distance between flattening plates in mm;

$e$  = constant for a given grade of steel:

= 0.08 for Grade 1, and

= 0.07 for Grade 2;

$t$  = specified wall thickness in mm; and

$D$  = specified outside diameter in mm.

Evidence of laminations or burnt material shall not develop during the entire flattening process.

**4.3.2 Bending Properties** — For tubes 50 mm and under in nominal diameter, a sufficient length of pipe shall stand being bent cold through 90° around a cylindrical mandrel, the diameter of which is 12 times the nominal diameter of the pipes, without developing cracks.

**4.3.3 Hydraulic Test** — When fittings are manufactured from pipes, the following are applicable:

- a) Each length of pipe used for manufacture of fittings of this specification shall be hydraulically tested by the pipe manufacturer to a test pressure which shall be determined by the following equation:

$$P = \frac{2St}{D}$$

where

$P$  = hydraulic test pressure in N/mm<sup>2</sup>,

$S$  = 0.60 times the specified yield stress in N/mm<sup>2</sup>,

$t$  = specified wall thickness in mm, and

$D$  = specified outside diameter in mm.

- b) The maximum hydraulic test pressure shall not exceed 17.25 N/mm<sup>2</sup>, for nominal sizes 80 mm and under and 19.31 N/mm<sup>2</sup> for nominal sizes over 80 mm. The higher test pressure may be used on agreement between the manufacturer and the purchaser, but in no case it shall exceed the pressure calculated from the equation specified in 4.3.3(a).
- c) The hydraulic pressure shall be maintained for not less than 5 seconds.

## 5. PRESSURE RATING

5.1 Fittings shall be designed for the pressure rating calculated for straight seamless pipes of the same size, nominal wall thickness and equivalent material with which they are recommended for use.

## 6. MANUFACTURE

6.1 Seamless fittings may be made by any suitable manufacturing process. Steel shall be of fully killed type.

6.2 Shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, or fusion welding or by a combination of two or more of these operations. The forming procedure shall be so applied that it will not produce injurious defects in the fittings.

6.3 Fittings fabricated by welding shall be made by welds, qualified welding operator and welding procedures under the provisions of IS : 2825-1969\*, IBR or other codes mutually agreed upon and heat-treated in accordance with 10 and radiographically examined throughout the entire length of each fabricated weld.

## 7. HARDNESS

7.1 Fittings shall have maximum hardness of 197 *BHN*.

## 8. TENSILE PROPERTIES

8.1 The material shall conform to the tensile properties as given in Table 3.

**TABLE 3 TENSILE PROPERTIES**

PROPERTY	GRADE I		GRADE II	
	330		415	
Tensile Strength, <i>Min</i> , MPa	205		240	
Yield Strength, <i>Min</i> , MPa				
	Longitu- dinal	Trans- verse	Longitu- dinal	Trans- verse
Elongation in 50 mm <i>Min</i> in percent:				
Basic minimum elongation for walls 7.9 mm and over in thickness, strip tests, and for all small sizes tested in full section	35	25	30	16.5
When standard round 50 mm gauge length test specimen is used	28	20	22	12

\*Code for unfired pressure vessel.

## 9. RADIOGRAPHIC TEST — FABRICATED FITTINGS

**9.1** Each fitting made by fabrication method shall be tested radiographically in accordance with IS 4853-1968\*.

## 10. HEAT TREATMENT

**10.1** Seamless carbon steel fittings on which the final forming operation is completed in the range of 620 to 980°C need not be heat-treated provided they are cooled in still air.

**10.2** Fittings completed at temperature above 980°C shall be subsequently normalized and fittings completed at the temperature below 620°C shall be stress-relieved in the range of 600 to 650°C or normalized. Soaking period shall not be less than 2.5 minutes per mm thickness but in no case shall be less than 30 minutes.

## 11. DIMENSIONS

**11.1** Size of the pipe shall correspond to the size of the fitting with respect to outer diameter/nominal pipe size (*see* Table 4).

**11.1.1** Thickness shall be according to Table 4 and other dimensions shall be according to Part 2 of the standard.

**11.1.2** Fittings in special thickness may be made from next higher standard thickness by boring the welding ends to 1 in 4 taper.

### 11.2 Dimensions of Welding Ends

**11.2.1** Dimensions of the welding ends shall match with those of the equivalent straight pipe subject to tolerances given in 12.

**11.2.2** In order to obtain the proper dimensions at the welding ends, it is permissible to machine the inside of the fittings to a taper of not less than 1 in 4 from next higher thickness. Tapering from further higher thickness may be made as agreed between the purchaser and the manufacturer.

**11.3 Welding Ends Preparation** — Unless otherwise specified by the purchaser the angle of the welding ends shall be as follows:

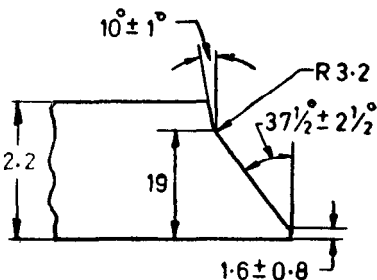
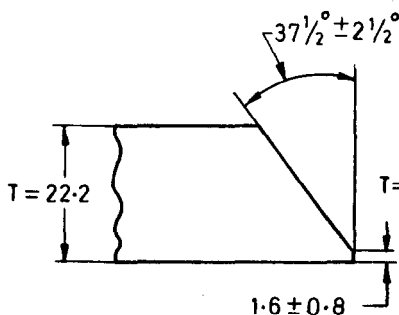
**11.3.1** Where the wall thickness at the welding ends is less than 4.8 mm, the ends shall be machined slightly chamfered or may be square at the manufacturers option.

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\*Recommended practice for radiographic examination of fusion welded circumferential joints in steel pipes.

**11.3.2** Where the wall thickness at the welding ends varies from 4.8 to 22.2 mm inclusive, the ends shall be machined to the form indicated in Fig. 1.

**11.3.3** Where the wall thickness at the welding ends is over 22.2 mm the ends shall be machined to the form indicated in Fig. 2.



All dimensions in millimetres.

FIG. 1 WELDING END FOR WALL THICKNESS FROM 4.8 mm UP TO AND INCLUDING 22.2 mm

FIG. 2 WELDING END FOR WALL THICKNESS GREATER THAN 22.2 mm

## 12. TOLERANCES

**12.1 Wall Thickness** — The wall thickness of a fitting shall at no point be less than 87.5 percent of the specified thickness.

**12.2 Outside Diameters at Welding Ends** — The tolerances permitted on the outside diameters of fittings at their welding ends shall be according to Part 3 of this standard.

**12.3 Inside Diameters at Welding Ends** — The tolerances permitted on the inside diameters of fittings at their welding ends shall be according to Part 3 of this standard.

**12.4 Angle of Bevel at Welding Ends** — Tolerances permitted on the angle of bevel of the welding ends of the fittings shall be as indicated in Fig. 1 and 2.

**12.5 Angularity Tolerance** — The angularity tolerance, that is, 'off angle and off plane' shall be according to Part 3 of this standard.



TABLE 4 OUTSIDE DIAMETERS AND THICKNESSES OF FITTINGS

( Clauses 11.1 and 11.1.1 )

NOMINAL PIPE SIZE	OUTSIDE DIA	THICKNESS, mm												
		Sch 10	Sch 20	Sch 30	Sch 40	Std	Sch 60	Sch 80	Extra Strong	Sch 100	Sch 120	Sch 140	Sch 160	Double Extra Strong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
mm	mm													
15	21.3	—	—	—	2.77	2.77	—	3.73	3.73	—	—	—	4.78	7.47
20	26.7	—	—	—	2.87	2.87	—	3.91	3.91	—	—	—	5.56	7.82
25	33	—	—	—	3.38	3.38	—	4.55	4.55	—	—	—	6.35	9.09
32	42.2	—	—	—	3.56	3.56	—	4.85	4.85	—	—	—	6.35	9.70
40	48.3	—	—	—	3.68	3.68	—	5.08	5.08	—	—	—	7.14	10.15
50	60.3	—	—	—	3.91	3.91	—	5.54	5.54	—	—	—	8.74	11.07
65	73.0	—	—	—	5.16	5.16	—	7.01	7.01	—	—	—	9.53	14.02
80	88.9	—	—	—	5.49	5.49	—	7.62	7.62	—	—	—	11.13	15.24
90	101.6	—	—	—	5.74	5.74	—	8.08	8.08	—	—	—	—	—
100	114.3	—	—	—	6.02	6.02	—	8.56	8.56	—	11.13	—	13.49	17.12
125	141.3	—	—	—	6.55	6.55	—	9.53	9.53	—	12.70	—	15.88	19.05
150	168.3	—	—	—	7.11	7.11	—	10.97	10.97	—	14.27	—	18.26	21.95
200	219.1	—	6.35	7.04	8.18	8.18	10.31	12.70	12.70	15.09	18.26	20.62	23.01	22.23
250	273.1	—	6.35	7.80	9.27	9.27	12.70	15.09	—	18.26	21.44	25.40	28.58	25.40
300	323.1	—	6.35	8.38	10.31	9.53	14.27	17.48	—	21.44	25.40	28.58	33.32	25.40
350	355	6.35	7.92	9.32	11.13	—	15.09	19.05	—	23.83	27.79	31.75	35.71	—
400	406	6.35	7.92	9.53	12.70	12.70	16.66	21.44	—	26.19	30.96	36.53	40.49	—
450	457	6.35	7.92	11.13	14.27	—	19.05	23.83	—	29.36	34.93	39.67	45.24	—
500	508	6.35	9.53	12.70	15.09	—	20.62	26.19	—	32.54	38.10	44.45	50.01	—
550	559	6.35	9.53	12.70	—	—	22.23	28.58	—	34.93	41.28	47.63	53.98	—
600	610	6.35	9.53	14.27	17.48	—	24.61	30.56	—	38.89	46.02	52.37	59.54	—
650	660	7.92	12.7	—	—	9.53	—	—	12.7	—	—	—	—	—
700	711	7.92	12.7	15.88	—	9.53	—	—	12.7	—	—	—	—	—
750	762	7.92	12.7	15.88	—	9.53	—	—	12.7	—	—	—	—	—
800	813	7.92	12.7	15.88	17.48	9.53	—	—	12.7	—	—	—	—	—
850	864	7.92	12.7	15.88	17.48	9.53	—	—	12.7	—	—	—	—	—
900	914	7.92	12.7	15.88	19.05	9.53	—	—	12.7	—	—	—	—	—
950	965	—	—	—	—	9.53	—	—	12.7	—	—	—	—	—
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1 050	1 067	—	—	—	—	9.53	—	—	12.7	—	—	—	—	—
1 100	1 118	—	—	—	—	9.53	—	—	12.7	—	—	—	—	—
1 150	1 168	—	—	—	—	9.53	—	—	12.7	—	—	—	—	—
1 200	1 219	—	—	—	—	9.53	—	—	12.7	—	—	—	—	—

NOTE 1 — 76.0 mm OD also be used if required by the purchaser.

NOTE 2 — Schedule numbers are given as a convenient designation for ordering pipes.

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### 13. WORKMANSHIP AND FINISH

**13.1** The fittings shall be free of injurious defects and shall have a workmanlike finish. At the discretion of the inspector representing the purchaser, finished fittings shall be subject to rejection if surface defects acceptable under **13.3** are not scattered but appear over a large area in excess of what is considered a workmanlike finish.

**13.2 Depth of Injurious Defects** — All defects shall be explored for depth. When the depth is in excess of 12.5 percent of the nominal wall thickness or encroaches on the minimum wall thickness, such defects shall be considered injurious.

**13.3** Machining or grinding defects not classified as injurious surface defects shall be treated as follows.

**13.3.1** Fittings showing scabs, seams, laps, tears, or slivers not deeper than 5 percent of the nominal wall thickness need not have these defects removed. If deeper than 5 percent, such defects shall be removed by machining or grinding.

**13.3.2** Fittings showing inside or outside surface cracks (Fish scale) 0.4 mm or less in depth need not have these defects removed. Such defects over 0.4 mm but not more than 0.8 mm in depth shall be removed by grinding. Fittings on which these defects are more than 0.8 mm in depth shall be rejected unless the manufacturer demonstrates to the purchaser that the defects are not injurious as defined in **13.1** to **13.3.1**.

**13.3.3** Mechanical marks or abrasions and pits shall be acceptable without grinding or machining provided the depth does not exceed the limitations set forth in **13.1** to **13.3.1**, and if not deeper than 1.6 mm. If such defects are deeper than 1.6 mm, but not deeper than 12.5 percent of the nominal wall thickness they shall be removed by grinding or machining to sound metal.

**13.3.4** When defects have been removed by grinding or machining the outside diameter at the point of grinding or machining may be reduced by the amount removed. Should it be impracticable to secure a direct measurement, the wall thickness at the point of grinding, or at a defect not required to be removed, shall be determined by deducting the amount removed by grinding, or the depth of the defect from the minimum measured wall thickness at the ends of the fittings, and the remainder shall not be less than 87.5 percent of the nominal wall thickness.

**13.3.5** Machining or grinding shall follow the inspection at the mill, of the fittings as formed and shall be followed by supplementary visual inspection.

**13.3.6 Repair by Welding** — Repair of injurious defects shall be permitted only subject to the approval of the purchaser and with the further understanding that the composition of the welding rod shall be suitable for the composition of the metal being welded. Welding of injurious defects in no case shall be permitted when the depth of defect exceeds 33·5 percent of the wall thickness or the length of repair exceeds 25 percent of the nominal diameter of the fitting. Defects should be thoroughly removed by chipping or grinding before welding, and then heat treated in accordance with 10.

## **14. PROTOTYPE BURSTING TESTS**

**14.1** Bursting tests shall be made in the following manner.

**14.1.1** Straight seamless pipe of the same material and the same nominal wall thickness as the fitting to be tested and having a length equal to at least twice the pipe outside diameter shall be welded to each end of the fitting. Closures beyond the minimum length of the pipe shall be welded to the pipe ends.

**14.1.2** Hydrostatic pressure shall be applied to the assembly and increased until either the fitting or one of the pipes burst.

**14.1.3** The fitting shall be considered satisfactory if the pressure attained on bursting is equal to or greater than the computed bursting pressure of the straight pipe as ascertained by the formula:

$$P = \frac{2St}{D}$$

where

$P$  = bursting pressure of the pipe,

$S$  = minimum specified tensile strength of the pipe material,

$t$  = 87·5 percent of the nominal pipe wall thickness, and

$D$  = outside diameter of the pipe.

**14.1.4** If so specified by the purchaser, the manufacturer shall supply certificates stating that satisfactory bursting tests have been carried out on prototype fittings of the types and sizes covered by the purchaser's order.

## **15. RADIOGRAPHIC EXAMINATION OF FITTINGS FABRICATED BY FUSION WELDING**

**15.1** Radiographic examination of fabricated fittings shall be 100 percent and throughout the entire length of their welds. The radiographic examination shall be done in accordance with IS : 4853-1982\*.

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\*Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes ( *first revision* ).

**15.2** The acceptance standard for radiographic inspection as defined in 15.2.1 may be included.

**15.2.1** Sections of the weld that are shown by radiography to have any of the following types of imperfection shall be judged unacceptable and shall be repaired and the repairs radiographed:

- a) Any type of crack or zone of incomplete fusion or penetration.
- b) Any elongated slag inclusion which has length greater than 6 mm for thickness up to 20 mm and  $\frac{1}{3} T$  for thickness above 20 mm, where  $T$  = thickness of the fitting. The width of the slag inclusion shall not exceed 1.6 mm or 20 percent  $T$  whichever is less.
- c) Any group of slag inclusions in line that have an aggregate length greater than  $T$  in a length of  $12 T$ , except when the distance between the successive imperfections exceeds  $6 L$  where  $T$  is the thickness of the fitting and  $L$  is the length of the longest imperfection in the group.
- d) The total area of porosity as determined from the radiographs shall not exceed  $1.5 \times T \text{ mm}^2$  in any 150 mm length of weld where the  $T$  is the thickness of the weld. If the weld is less than 150 mm long, the total area of porosity shall be reduced in proportion.
- e) The maximum bore dimension shall be 20 percent of  $T$  or 1.6 mm whichever is smaller.
- f) Where defects occur in distributed positions in a seam, repairs to the extent of 15 percent of the total length of the seam shall be permitted to replace the defective welding.
- g) When, however, the defects are all located in a single continuous length which may be cut out to remove all defects, it shall not exceed 10 percent of the total length of the seam.

**15.3 Inspection** — The manufacturer shall provide to the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with the specification. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

**15.4 Certification** — A certificate that the material conforms to the requirement of this specification shall be the basis of acceptance of the material. The manufacturer shall report to the purchaser the results of the chemical analysis and mechanical tests and heat treatment applied to the material.

**15.5 Basis of Purchase** — Order for material under this specification shall include the following information:

- a) Type and quality of fittings;
- b) Nominal size and wall thickness;
- c) Material grade;
- d) Seamless or fabricated; and
- e) Supplementary requirements, if any.

**15.6 Supplementary Requirements** — These are optional and shall be as specified in each case.

**15.6.1 Product Analysis** — A product analysis shall be made from each heat of base metal and if of welded construction from each lot number of welding material of the fittings offered for delivery. The analysis shall conform to the requirements specified in Table 2.

**15.6.2 Tension Test** — One tension test shall be made on one fitting or representative test piece per lot of fittings. If the fittings are of welded construction, the tension specimen shall include the weld and be prepared so that the weld is at the midlength location of the specimen. However, in no case shall the tensile properties of the finished fittings be less than the requirements specified in Table 3.

**NOTE 1 — Representative Test Piece** — Where the test specimen for the tension test cannot be taken from a fitting due to size limitations a representative test piece shall be obtained. The test piece shall be from the same heat and heat-treated in the same batch or charge as the fittings it represents and shall have approximately the same amount of working. In addition, test pieces representing fittings manufactured from bars, plate, or forgings shall have a cross section equal to the greatest cross section of the fitting, and test pieces representing fittings manufactured from pipe shall have an outside diameter and wall thickness equal to those of the fitting. The test piece for fittings of welded construction shall be prepared to the same weld procedure and from the same heats of material as the fittings it represents.

**NOTE 2** — A lot shall consist of all fittings of the same type, size and wall thickness, manufactured from one heat of material ( and if welding is performed using one lot number of electrodes of one heat of weld wire, and one lot number of flux ), heat treated in either a continuous or batch-type furnace equipped with recording pyrometers so that complete records of heat treatment are available.

**15.6.3 Liquid Penetrant Test** — All surfaces shall be liquid penetrant, tested. The method shall be in accordance with IS : 3658-1981\*. Acceptance limits shall be as specified by the purchaser.

**15.6.4 Magnetic-Particle Test** — All accessible surfaces shall be magnetic particle inspected in accordance with IS : 3703-1980†. Acceptance limits shall be as specified by the purchaser.

\*Code of practice for liquid penetrant flaw detection ( first revision ).

†Code of practice for magnetic particle flaw detection ( first revision ).

## 16. HYDROSTATIC TESTING

**16.1** Hydrostatic testing of seamless fittings is not required by this standard.

**16.2** Hydrostatic testing of fabricated fittings shall be applied as specified by the purchaser in his order. The test pressure shall be determined by the following formula:

$$P = \frac{2St}{D}$$

where

$P$  = minimum test pressure,

$S$  = 60 percent of the minimum specified yield stress of the material of which the fitting is made,

$t$  = nominal wall thickness of the fittings, and

$D$  = outside diameter of the fitting at the bevel.

## 17. MARKING

**17.1** All fittings shall be marked with the following details:

- a) Manufacturer's name or trade-mark,
- b) Grade of material,
- c) Nominal wall thickness in mm, and
- d) Nominal size in mm.

**17.2** Where the size of the fitting does not permit complete marking, identification marks may be omitted in the reverse of the order presented above.

**17.3** Each fitting complying with this part and specific requirements given in the relevant part may also be marked with the ISI Certification Mark.

**NOTE** — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

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# *Indian Standard*

## SPECIFICATION FOR WROUGHT CARBON STEEL BUTT-WELDING PIPE FITTINGS

### **PART 2 SHAPES AND DIMENSIONS**

#### **1. SCOPE**

**1.1** This standard ( Part 2 ) lays down the requirements for shapes and dimensions for steel elbows, returns, tees, crosses, reducers and caps given in Tables 1 to 7.

#### **2. REQUIREMENTS**

**2.1** The general requirements for designation, material, wall thickness, freedom from defects, tests, finish and marking shall conform to those given in Part 1 of this standard.

#### **3. DIMENSIONS**

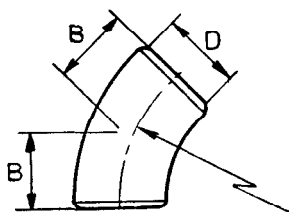
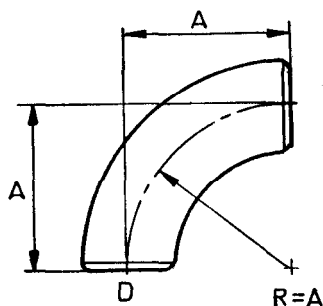
**3.1** Dimensions of the fittings shall be according to Tables 1 to 7.

#### **4. TOLERANCES**

**4.1** Tolerances on different types of fittings shall be as given in Table 1 of Part 3 in this standard.

TABLE 1 DIMENSIONS OF LONG RADIUS ELBOWS

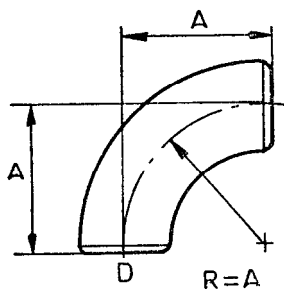
( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL <i>D</i> NOMINAL	CENTRE-TO-END	
		90° Elbows, <i>A</i> Nominal	45° Elbows, <i>B</i> Nominal
(1)	(2)	(3)	(4)
mm	mm	mm	mm
15	21	38	16
20	27	29	11
25	33	38	22
32	42	48	25
40	48	57	29
50	60	76	35
65	73	95	44
80	89	114	51
90	102	133	57
100	114	152	64
125	141	190	79
150	168	229	95
200	219	305	127
250	273	381	159
300	324	457	190
350	356	533	222
400	406	610	254
450	457	686	286
500	508	762	318
550	559	838	343
600	610	914	381
650	660	991	406
700	711	1 067	438
750	762	1 143	470
800	813	1 219	502
850	864	1 295	533
900	914	1 372	565
950	965	1 448	600
1 000	1 016	1 524	632
1 050	1 067	1 600	660
1 100	1 118	1 676	695
1 150	1 168	1 753	727
1 200	1 219	1 829	759

TABLE 2 DIMENSIONS OF SHORT RADIUS ELBOWS

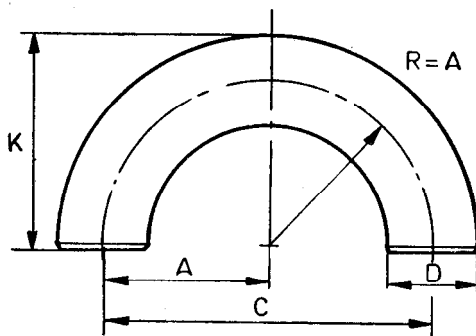
( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL, <i>D</i> NOMINAL	CENTRE-TO-END, <i>A</i> 90° ELBOWS NOMINAL
(1)	(2)	(3)
mm	mm	mm
25	33	25
32	42	32
40	48	38
50	60	51
65	73	64
80	89	76
90	102	89
100	114	102
125	141	127
150	168	152
200	219	203
250	273	254
300	324	305
350	356	356
400	406	406
450	457	457
500	508	508
550	559	559
600	610	610

TABLE 3 DIMENSIONS OF LONG RADIUS RETURNS

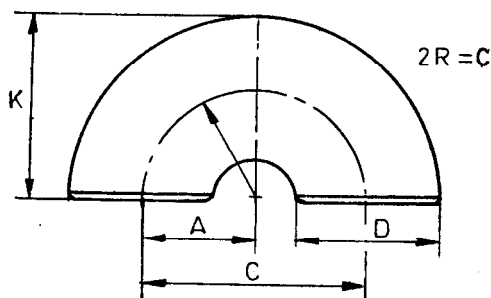
( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL $D$ , NOMINAL	CENTRE-TO-CENTRE $C$ , NOMINAL	BACK-TO-FACE $K$ , NOMINAL
(1)	(2)	(3)	(4)
mm	mm	mm	mm
15	21	76	48
20	27	57	43
25	33	76	56
32	42	95	70
40	48	114	83
50	60	152	106
65	73	191	132
80	89	229	159
90	102	267	184
100	114	305	210
125	141	381	262
150	168	457	313
200	219	610	414
250	273	762	518
300	324	914	619
350	356	1 067	711
400	406	1 219	813
450	457	1 372	914
500	508	1 524	1 016
550	559	1 676	1 118
600	610	1 829	1 219

TABLE 4 DIMENSIONS OF SHORT RADIUS 180° RETURNS\*

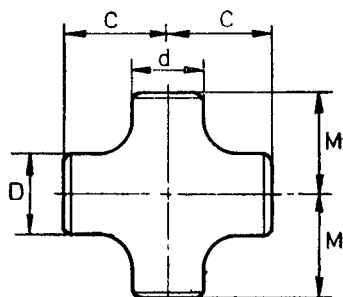
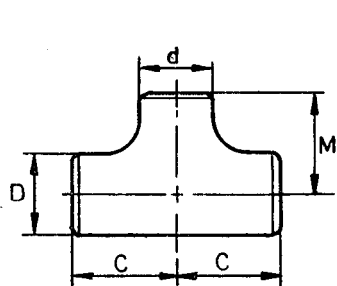
( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL $D$ , NOMINAL	CENTRE-TO-CENTRE, $C$ , NOMINAL	BACK-TO-FACE, $K$ , NOMINAL
(1)	(2)	(3)	(4)
mm	mm	mm	mm
25	33	51	41
32	42	64	52
40	48	76	62
50	60	102	81
65	73	127	100
80	89	152	121
90	102	178	140
100	114	203	159
125	141	254	197
150	168	305	237
200	219	406	313
250	273	508	391
300	324	610	467
350	356	711	533
400	406	813	610
450	457	914	686
500	508	1 016	762
550	559	1 118	838
600	610	1 219	914

TABLE 5 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES

( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER OF REDUCING TEES AND CROSSES		CENTRE-TO-END LENGTHS OF TEES AND CROSSES	
	Run, <i>D</i> , Nominal	Outlet, <i>d</i> , Nominal	Run, <i>C</i> , Nominal	Outlet, <i>M</i> , Nominal
(1)	(2)	(3)	(4)	(5)
mm × mm × mm	mm	mm	mm	mm
15 × 15 × 10	21	17	25	25
15 × 15 × 6	21	14	25	25
20 × 20 × 15	27	21	29	29
20 × 20 × 10	27	17	29	29
25 × 25 × 20	33	27	38	38
25 × 25 × 15	33	21	38	38
32 × 32 × 25	42	33	48	48
32 × 32 × 20	42	27	48	48
32 × 32 × 15	42	21	48	48
40 × 40 × 32	48	42	57	57
40 × 40 × 25	48	33	57	57
40 × 40 × 20	48	27	57	57
40 × 40 × 15	48	21	57	57
50 × 50 × 40	60	48	64	60
50 × 50 × 32	60	42	64	57
50 × 50 × 25	60	33	64	51
50 × 50 × 20	60	27	64	44
65 × 65 × 50	73	60	76	70
65 × 65 × 40	73	48	76	67
65 × 65 × 32	73	42	76	64
65 × 65 × 25	73	33	76	57

( Continued )

TABLE 5 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES — *Contd*

NOMINAL PIPE SIZE	OUTSIDE DIAMETER OF REDUCING TEES AND CROSSES		CENTRE-TO-END LENGTHS OF TEES AND CROSSES	
	Run, <i>D</i> , Nominal	Outlet, <i>d</i> , Nominal	Run, <i>C</i> , Nominal	Outlet, <i>M</i> , Nominal
(1)	(2)	(3)	(4)	(5)
mm × mm × mm	mm	mm	mm	mm
80 × 80 × 65	89	73	86	83
80 × 80 × 50	89	60	86	76
80 × 80 × 40	89	48	86	73
80 × 80 × 32	89	42	86	70
90 × 90 × 80	102	89	95	92
90 × 90 × 65	102	73	95	89
90 × 90 × 50	102	60	95	83
90 × 90 × 40	102	48	95	79
100 × 100 × 90	114	102	105	102
100 × 100 × 80	114	89	105	98
100 × 100 × 65	114	73	105	95
100 × 100 × 50	114	60	105	89
100 × 100 × 40	114	48	105	86
125 × 125 × 100	141	114	124	117
125 × 125 × 90	141	102	124	114
125 × 125 × 80	141	89	124	111
125 × 125 × 65	141	73	124	108
125 × 125 × 50	141	60	124	105
150 × 150 × 125	168	141	143	137
150 × 150 × 100	168	114	143	130
150 × 150 × 90	168	102	143	127
150 × 150 × 80	168	89	143	124
150 × 150 × 65	168	73	143	121
200 × 200 × 150	219	168	178	168
200 × 200 × 125	219	141	178	162
200 × 200 × 100	219	114	178	156
200 × 200 × 90	219	102	178	152

( *Continued* )

TABLE 5 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES — *Contd*

NOMINAL PIPE SIZE  (1)	OUTLET DIAMETER OF REDUCING TEES AND CROSSES		CENTRE-TO-END LENGTHS OF TEES AND CROSSES	
	Run, <i>D</i> , Nominal (2)	Outlet, <i>d</i> , Nominal (3)	Run, <i>C</i> , Nominal (4)	Outlet, <i>M</i> , Nominal (5)
mm × mm × mm	mm	mm	mm	mm
250 × 250 × 200	273	219	216	203
250 × 250 × 150	273	168	216	194
250 × 250 × 125	273	141	216	191
250 × 250 × 100	273	114	216	184
300 × 300 × 250	324	273	254	241
300 × 300 × 200	324	219	254	229
300 × 300 × 150	324	168	254	219
300 × 300 × 125	324	140	254	216
350 × 350 × 300	356	324	279	270
350 × 350 × 250	356	273	279	257
350 × 350 × 200	356	219	279	248
350 × 350 × 150	356	168	279	238
400 × 400 × 350	406	356	305	305
400 × 400 × 300	406	324	305	295
400 × 400 × 250	406	273	305	283
400 × 400 × 200	406	219	305	273
400 × 400 × 150	406	168	305	264
450 × 450 × 400	457	406	343	330
450 × 450 × 350	457	356	343	330
450 × 450 × 300	457	324	343	321
450 × 450 × 250	457	273	343	308
450 × 450 × 200	457	219	343	298
500 × 500 × 450	508	457	381	368
500 × 500 × 400	508	406	381	356
500 × 500 × 350	508	356	381	356
500 × 500 × 300	508	324	381	346
500 × 500 × 250	508	273	381	333
500 × 500 × 200	508	219	381	324

( *Continued* )



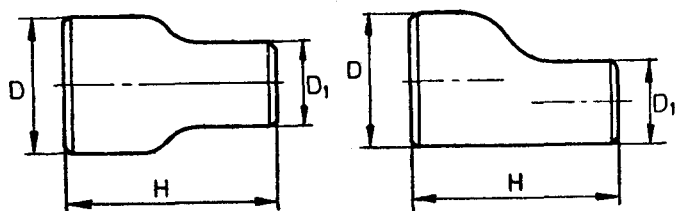
**TABLE 5 DIMENSIONS OF REDUCING OUTLET TEES AND  
REDUCING OUTLET CROSSES — *Contd***

NOMINAL PIPE SIZE	OUTLET DIAMETER OF REDU- CING TEES AND CROSSES		CENTRE-TO-END LENGTHS OF TEES AND CROSSES	
	Run, <i>D</i> , Nominal	Outlet, <i>d</i> , Nominal	Run, <i>C</i> , Nominal	Outlet, <i>M</i> , Nominal
(1)	(2)	(3)	(4)	(5)
mm × mm × mm	mm	mm	mm	mm
550 × 550 × 500	559	508	419	406
550 × 550 × 450	559	457	419	394
550 × 550 × 400	559	406	419	381
550 × 550 × 350	559	356	419	381
550 × 550 × 300	559	324	419	371
550 × 550 × 250	559	273	419	359

NOTE — Outlet dimensions *M* for run sizes 350 and larger is recommended but not mandatory.

TABLE 6 DIMENSIONS OF REDUCERS

( Clause 3.1 )



NOMINAL PIPE SIZE	O. D. OF LARGE END, $D$ , NOMINAL	O. D. OF SMALL END $D_1$ , NOMINAL	END-TO-END LENGTH OF REDUCERS, $H$ , NOMINAL
(1)	(2)	(3)	(4)
mm $\times$ mm	mm	mm	mm
20 $\times$ 15	27	21	38
20 $\times$ 10	27	17	38
25 $\times$ 20	33	27	51
25 $\times$ 15	33	21	51
32 $\times$ 25	42	33	51
32 $\times$ 20	42	27	51
32 $\times$ 15	42	21	51
40 $\times$ 32	48	42	64
40 $\times$ 25	48	33	64
40 $\times$ 20	48	27	64
40 $\times$ 15	48	21	64
50 $\times$ 40	60	48	76
50 $\times$ 32	60	42	76
50 $\times$ 25	60	33	76
50 $\times$ 20	60	27	76
65 $\times$ 50	73	60	89
65 $\times$ 40	73	48	89
65 $\times$ 32	73	42	89
65 $\times$ 25	73	33	89
80 $\times$ 65	89	73	89
80 $\times$ 50	89	60	89
80 $\times$ 40	89	48	89
80 $\times$ 32	89	42	89

( Continued )

TABLE 6 DIMENSIONS OF REDUCERS — *Contd*

NOMINAL PIPE SIZE	O. D. OF LARGE END, $D$ , NOMINAL	O. D. OF SMALL, END, $D_1$ , NOMINAL	END-TO-END LENGTH OF REDUCERS, $H$ , NOMINAL
(1) mm × mm	(2) mm	(3) mm	(4) mm
90 × 80	102	89	102
90 × 65	102	73	102
90 × 50	102	60	102
90 × 40	102	48	102
90 × 32	102	42	102
100 × 90	114	102	102
100 × 80	114	89	102
100 × 65	114	73	102
100 × 50	114	60	102
100 × 40	114	48	102
125 × 100	141	114	127
125 × 90	141	102	127
125 × 80	141	89	127
125 × 65	141	73	127
125 × 50	141	60	127
150 × 125	168	141	140
150 × 100	168	114	140
150 × 90	168	102	140
150 × 80	168	89	140
150 × 65	168	73	140
200 × 150	219	168	152
200 × 125	219	141	152
200 × 100	219	114	152
200 × 90	219	102	152
250 × 200	273	219	178
250 × 150	273	168	178
250 × 125	273	141	178
250 × 100	273	114	178

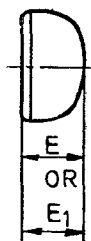
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**TABLE 6 DIMENSIONS OF REDUCERS — Contd**

NOMINAL PIPE SIZE	O. D. OF LARGE END, $D_2$ , NOMINAL	O. D. OF SMALL END, $D_1$ , NOMINAL	END-TO-END LENGTH OF REDUCERS, $H$ , NOMINAL
(1)	(2)	(3)	(4)
mm × mm	mm	mm	mm
300 × 250	324	273	203
300 × 200	324	219	203
300 × 150	324	168	203
300 × 125	324	141	203
350 × 300	356	324	330
350 × 250	356	273	330
350 × 200	356	219	330
350 × 150	356	168	330
400 × 350	406	356	356
400 × 300	406	324	356
400 × 250	406	273	356
400 × 200	406	219	356
450 × 400	457	406	381
450 × 350	457	356	381
450 × 300	457	324	381
450 × 250	457	273	381
500 × 450	508	457	508
500 × 400	508	406	508
500 × 350	508	356	508
500 × 300	508	324	508
550 × 500	559	508	508
550 × 450	559	457	508
550 × 400	559	406	508
550 × 350	559	356	508
600 × 550	610	559	508
600 × 500	610	508	508
600 × 450	610	457	508
600 × 400	610	406	508
650 × 600	660	610	610
650 × 550	660	559	610
650 × 500	660	508	610
650 × 450	660	457	610

TABLE 7 DIMENSIONS OF CAPS\*

( Clause 3.1 )



NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL, $D$ , NOMINAL	LENGTH†, $E$ , NOMINAL	LIMITING WALL THICKNESS FOR LENGTH, $E$ , NOMINAL	LENGTH‡, $E_1$ , NOMINAL
(1)	(2)	(3)	(4)	(5)
mm	mm	mm	mm	mm
15	21	25	3.73	25
20	27	25	3.91	25
25	33	38	4.55	38
32	42	38	4.85	38
40	48	38	5.08	38
50	60	38	5.54	44
65	73	38	7.01	51
80	89	51	7.62	64
90	102	64	8.08	76
100	114	64	8.56	76
125	141	76	9.53	89
150	168	89	10.97	102
200	219	102	12.70	127
250	273	127	12.70	152
300	324	152	12.70	178
350	356	165	12.70	191

\*The shape of these caps shall be ellipsoidal.

†Length  $E$  applies for thickness not exceeding given in col 4.‡Length  $E_1$  applies for thickness greater than that given in col 4 for nominal pipe size 600 and smaller. For nominal pipe size 650 and larger, length  $E_1$  shall be agreed between the manufacturer and the purchaser.

( Continued )

TABLE 7 DIMENSIONS OF CAPS\* — *Contd*

NOMINAL PIPE SIZE	OUTSIDE DIAMETER AT BEVEL, $D$ , NOMINAL	LENGTH†, $E$ , NOMINAL	LIMITING WALL THICKNESS FOR LENGTH, $E$ , NOMINAL	LENGTH‡, $E_1$ , NOMINAL
(1)	(2)	(3)	(4)	(5)
mm	mm	mm	mm	mm
400	406	178	12·70	203
450	457	203	12·70	229
500	508	229	12·70	254
550	559	254	12·70	254
600	610	267	12·70	305
650	660	267		
700	711	267		
750	762	267		
800	813	267		
850	864	267		
900	914	267		
950	965	305		
1 000	1 016	305		
1 050	1 067	305		
1 100	1 118	343		
1 150	1 168	343		
1 200	1 219	343		

\*The shape of these caps shall be ellipsoidal.

†Length  $E$  applies for thickness not exceeding given in col 4.

‡Length  $E_1$  applies for thickness greater than that given in col 4 for nominal pipe size 600 and smaller. For nominal pipe size 650 and larger, length  $E_1$  shall be agreed between the manufacturer and the purchaser.

*Indian Standard*

**SPECIFICATION FOR  
WROUGHT CARBON STEEL BUTT-WELDING  
PIPE FITTINGS**

**PART 3 TOLERANCES**

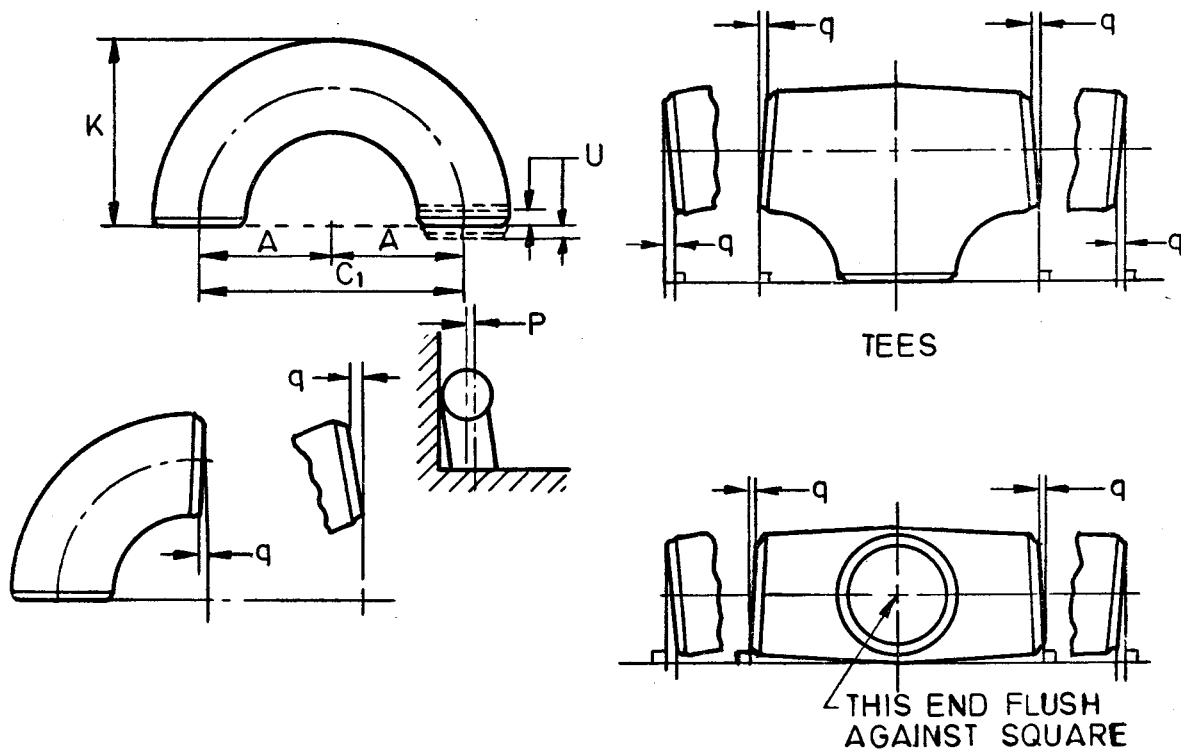
**1. SCOPE**

**1.1** This standard ( Part 3 ) lays down the requirements of tolerances for wrought carbon steel butt-welding pipe fittings.

**2. TOLERANCES**

**2.1** The tolerances on dimensions shall be as given in Table 1 for various types of fittings.

TABLE 1 TOLERANCES





NOMINAL PIPE SIZE	ALL FITTINGS			90° AND 45° ELBOWS AND TEES CENTRE-TO- END DIMENSION A, B, C, M A, B, C, M	REDU- CERS AND LAP JOINTS, OVER- ALL LENG- TH H	CAPS, OVER- ALL LENG- TH E	180° RETURNS		
	Outside* Diameter at Bevel D	Inside† Diameter at End	Wall Thick- ness t				Centre- to-Centre Dimension C <sub>1</sub>	Back- to-Face Dimension K	Align- ment of Ends U
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
15 to 65	± 1	± 0.8	Not less than 87.5% of nominal thickness	± 2	± 2	± 4	± 7	± 7	± 1
80 to 90	± 1	± 1.6		± 2	± 2	± 4	± 7	± 7	± 1
100	+ 2 - 1	± 1.6		± 2	± 2	± 4	± 7	± 7	± 1
125 to 150	+ 3 - 1	± 1.6		± 2	± 2	± 7	± 7	± 7	± 1
200	± 2	± 1.6		± 2	± 2	± 7	± 7	± 7	± 1
250	+ 4 - 3	± 3.2		± 2	± 2	± 7	± 10	± 7	± 2
300 to 450	+ 4 - 3	± 3.2		± 3	± 3	± 7	± 10	± 7	± 2
500 to 600	+ 6 - 5	± 4.8		± 3	± 3	± 7	± 10	± 7	± 2
650 to 750	+ 7 - 5	± 4.8		± 3	± 3	± 10	—	—	—
800 to 1 200	+ 7 - 5	± 4.8		± 5	± 5	± 10	—	—	—

\*Out-of round is the sum of absolute values of plus and minus tolerance.

†The inside diameter at ends and the nominal wall thicknesses are to be specified by the purchaser.

*Nominal Pipe Size*

*Angularity Tolerance*

mm	Angularity Tolerance	
	Off Angle q	Off Plane P
15 to 100	± 1	± 2
125 to 200	± 2	± 4
250 to 300	± 3	± 5
350 to 400	± 3	± 7
450 to 600	± 4	± 10
650 to 750	± 5	± 10
800 to 1 050	± 5	± 13
1 100 to 1 200	± 5	± 20

( Continued from page 2 )

**Panel for Steel Pipe Flanges and Steel Pipe Fittings, SMDG 22 : P11**

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